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BASIC INVESTIGATIONS FOR REMOTE SENSING OF COASTAL AREAS.(U)
1976 R A SHUCHMAN, D R LYZENGA, F J THOMSON

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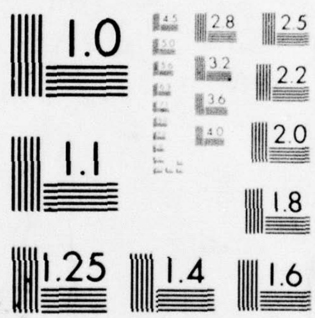

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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1.0 SUMMARY OF ACTIVITIES

During the quarterly period 16 July - 15 October 1976, three principle activities took place. The second year interim report was printed and distributed. Work was completed on obtaining critical optical properties of beach minerals to be used as inputs into the Beach and Environment Models. In the water modeling area, the water-atmosphere model was tested and used in a study for the Naval Coastal Systems Lab, and analysis of model results in the context of MRA development has begun. In connection with this task, a letter was sent to the Editor of Applied Optics on the reflectance of a flat ocean in the limit of zero water depth.

2.0 BEACH ENVIRONMENT MODELING - PROGRESS IN DETAIL

During this period, work on the Beach Environment Task consisted of completing data collection on critical optical and physical properties of common beach forming minerals. This data being primary inputs into the GCANOPY and AQUACAN models of Dr. Suits. As indicated in earlier ONR letter reports, the Suits' models need the index of refraction and coefficient of absorption in the .4 to 2.5 μm range for each mineral comprising the beach sand. The Suits' models also need the average cross section of each mineral type, the average number of grains (particles) per given volume, and the moisture depth profile on a millimeter scale. ERIM, using its Cary - 14 device, measured the hemispherical transmittance and reflection of each beach forming mineral at a number of prescribed thicknesses to obtain the needed absorption coefficient. This work is currently completed and will be extensively reported on in the third interim report.

To obtain moisture depth profiles of typical beaches on a

millimeter scale, ERIM initiated a careful search of the literature and consulted Dr. O. Huh of LSU as to the availability of this information. Like the needed optical properties of minerals, the moisture data at the millimeter profiling scale was not available. ERIM developed a measuring apparatus to obtain the moisture data for use in the AQUACAN model. Field measurements along Lake Huron and laboratory measurements using existing sand previously collected were measured to obtain volume of water as a function of depth from the top of the sand surface. These measurements satisfy the requirements for input into Suits' AQUACAN model.

A laboratory apparatus was also developed to empirically measure the "skin depth" of passive multispectral techniques. The empirically obtained skin depth measurements were compared to preliminary "skin depth" results obtained using the Suits' GCANOPY model. The results were in close agreement.

Work in the final quarter of the current contract will be to further evaluate and refine if necessary the Suits' models and then use the Suits' models to verify the presently developed beach moisture algorithm.

3.0 WATER MODELING TASK - PROGRESS IN DETAIL

The computer program (WATRAD) written during the last quarter has been tested and was used extensively in a study of the detectability of black submerged objects [1] for the Naval Coastal Systems Laboratory during this quarter. This model is essentially as described in the previous quarterly report, except that the effect of internal surface reflection is calculated assuming isotropy of the upward radiance just beneath the surface, and the effect of backscattering of light which

has been reflected from the bottom has been neglected. The water parameters for the NCSL study were taken from Jerlov (water types 1, 3, and 5) and Petzold (Stations 9, 5, and 2200) and the bottom reflectance values were taken from typical curves for sand, mud, and green vegetation.

A second generation of this program (WATRAD1) was also written during this period. This program calculates a series of radiances, as a function of water depth, for each set of input parameters and writes the results in a file. This file then represents a simulated data set which may be used as input to a variety of processing programs. Among the processing programs which have been written are (1) a program to plot radiances in one band versus radiances in another band; and (2) a program to calculate the pair-wise probability of misclassification for any pair of bottom types using any set of MRA parameters.

Preliminary results using these programs suggest that for any given operational situation (i.e., a given water type, set of bottom types, and a set of wavelength bands) the optimum results may not be obtained using the MRA algorithm with the deep-water signals used as offsets. In the first place, this algorithm is based on the premise that two bands exist for which the water attenuation coefficients are equal. In any given operational situation, this may not be the case. In the second place, if two such bands do exist, the ratio of the bottom reflectances in these bands may be the same or nearly the same for the bottom materials considered. In this case there is no way to separate these materials using these bands.

These considerations have led us to generalize the MRA to allow

the use of wavelength bands for which the attenuation coefficients are not equal, and to allow the use of offsets which are not equal to the deep water signals. We are now in the process of developing alternate criteria for band selection and offset selection in order to maximize the depth of separation. Our goals for the remainder of this year's effort are to (1) calculate the depth limits for separation of sand, mud, and vegetation using the conventional MRA (with deep-water signals used as offsets); (2) calculate the depth limits using the generalized MRA; (3) investigate the effects of changing water quality on the MRA performance; and, (4) to develop means of operationally maximizing the performance (i.e., selecting the proper parameters) of the generalized MRA if this algorithm proves superior to the conventional MRA.

REFERENCES

1. Lyzenga, D. R. and F. J. Thomson, Detectability of Black Submerged Objects, Report No. 123500-1-F, Environmental Research Institute of Michigan, Ann Arbor, 1976.